Bonn. zool. Beitr.	Bd. 50	H. 4	S. 355–368	Bonn, Januar 2003

A study on the geographical distribution along with habitat aspects of rodent species in Turkey

N. Yiğit, E. Çolak, M. Sözen & S. Özkurt

Abstract. Rodent species were collected in 20 selected localities, and these localities were then compared with regard to rodent species composition. A total of 41 rodent species was found in these localities, the number in each locality ranging from 9 to 17. Species previously recorded in mixed and deciduous forest in northern Asiatic Turkey, such as *Glis glis*, *Muscardinus avellanarius*, *Microtus subterraneus*, *Microtus roberti*, *Microtus majori*, *Sciurus vulgaris* and *Clethrionomys glareolus*, were not found in forested localities in west and south Asiatic Turkey with a dry summer season. *Apodemus agrarius* was only recorded from the Thracian region of Turkey. Similar habitats in different localities supported rodent assemblage with considerable differences in species composition. Vegetation structure, climate, and elevation were found to be the main factors affecting the distribution of rodent species in Turkey.

Key words. Rodent species, ecological analysis, biogeography, geographical ecology, Turkey.

Introduction

Turkey comprises 775.000 km^2 in Asia and 4.450 km^2 in Europe (Thrace), 779.450 km^2 in total. Corbet (1978) listed 217 rodent species in the Palaearctic region, including Turkey. Demirsoy (1996) stated in his brief review, 'The mammals of Turkey', that 61 rodent species occur in Turkey. The following authors have contributed to the known Turkish rodent fauna by providing distributions and records of new species and subspecies: Danford & Alston (1877); Thomas (1897, 1903, 1906 & 1919); Barret-Hamilton (1900); Nehring (1903); Satunin (1908); Miller (1908); Blackler (1916); Aharoni (1932); Neuhäuser (1936); Ellerman (1951); Misonne (1957); Kahmann (1961); Spitzenberger & Steiner (1964); Osborn (1962 & 1965); Steiner & Vauk (1966); Lehmann (1966 & 1969), Lay (1967); Felten & Storch (1968); Felten et al. (1971 & 1973); Mursaloğlu (1965 & 1973); Spitzenberger (1971 & 1978); Morlok (1978); Kıvanç (1983 & 1986); Doğramacı (1989); Doğramacı et al. (1994); Kurtonur & Özkan (1991); Çolak & Kıvanç (1991); Çolak et al. (1994, 1997a, 1997b, 1998 & 1999); Kefelīoğlu (1995); Filipucci et al. (1996); Coşkun (1996 & 1997); Yiğit et al. (1997a, 1997b, 1998a 1998b & 1998c); Yiğit & Çolak (1999); Özkurt et al. (1999). The number of rodent species in Turkey is now 61 according to the latest records. Although many rodent species have wide distribution areas in Turkey, information on geographical distributions, habitat peculiarities and ecology are insufficient. However, many studies on various aspects of rodent population structure, zoogeography, and ecology have been conducted in neighbouring areas by Thomas (1905); Zahavi & Wahrman (1957); Bodenheimer (1958); Misonne (1959); Hatt (1959); Ondrias (1966); Haim & Tchernov (1974); Atallah (1977);

Brown (1980). Land-use activities in Turkey such as farming in natural steppe areas, urban building and forestry dangerously affect the preservation of natural conditions for wildlife. That is why rodent species, like other mammal species, are threatened with extinction. The aims of this study were to inform authorities establishing conservation areas, and to contribute to the composition of species and distribution areas of rodent species in Turkey, as well as further investigations.

Materials and Methods

This study, carried out between the years 1991 and 1997, is based on specimens caught in various localities in Turkey (Fig. 1). These were generally the type localities and record areas of certain species, and detailed descriptions are provided here from 20 localities. When there were different habitat types in a selected locality, they were studied separately, each one consisting of close to the 500 1 ha plots. Meteorological records such as precipitation, mean temperature of the coldest month (m), mean temperature of the warmest month (M) and elevation of each locality were obtained from the nearest meteorological station. In addition, vegetation structure, and the latitude and longitude of the localities were determined. Field studies were usually conducted in spring and summer months. We worked in 20 localities in periods of 3 days between 1991–1997. 200 snap traps and 50 Sherman live traps were set in the field daily in the afternoon, and checked early in the morning so that trapped specimens would not be damaged by insects. Some of these traps were also set on tree branches to catch arboreal rodent species. Traps were baited with a mixture of roasted peanuts and bread. *Allactaga* species were caught with small insect nets thrown from a slowly moving car at night, and special traps were used to catch fossorial species. Four external character measurements (head and body, tail, hind foot and ear) and body weight were taken in the field. Cranial examinations were used along with these measurements to identify species. Additionally, the checklists of Corbet (1978) and Harrison & Bates (1991) were referred to for the identification of these species. The similarity coefficients were computed in order to compare rodent species composition in the localities by using NTSYS-pc computer programme according to Rohlf (1988). Skin and skulls of specimens were deposited at the University of Ankara, Faculty of Science, Department of Biology.

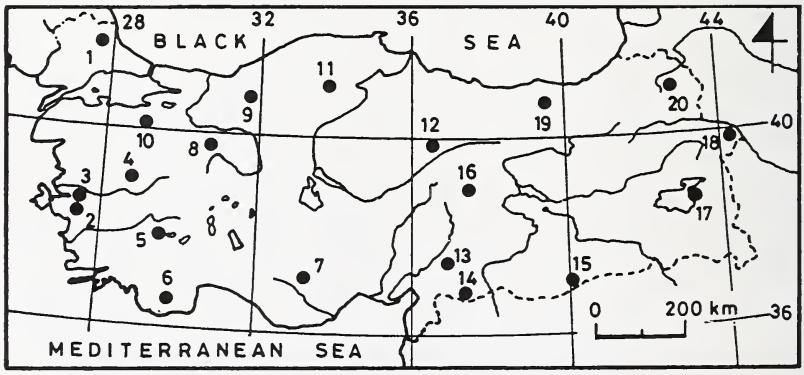

Fig. 1. Map showing localities of Turkish rodents recorded in this study. 1: Velika, Kırklareli, 2: Bayındır, İzmir, 3: Ovacık, İzmir, 4: Demirci, Manisa, 5: Çardak, Denizli, 6: Çığlıkara, Antalya, 7: Kılbasan, Karaman, 8: Gökçekısık, Eskisehir, 9: Abant, Bolu, 10: Yenikonak, Bursa, 11: Tosya, Kastamonu, 12: Yıldızelī, Sivas, 13: Türkoğlu, Kahramanmaras, 14: Kilis, 10 km east, 15: Ceylanpınar, Sanlıurfa, 16: Darende, Malatya, 17: Van, 10 km south, 18: Aralık, Iğdır, 19: Sümela, Trabzon, 20: Kars and Ardahan.

Abbreviations in text: **1. VEL:** Velika, Kırklareli, **2. BAY:** Bayındır, İzmīr, **3. OVA:** Ovacık, İzmīr, **4. DEM:** Demirci, Manisa, **5. ÇAR:** Çardak, Denizli, **6. ÇIG:** Çığlıkara, Antalya, **7. KIL:** Kılbasan, Karaman, **8. GOK:** Gökçekısık, Eskişehir, **9. ABA:** Abant, Bolu, **10. YEN:** Yenikonak, Bursa, **11. TOS:** Tosya, Kastamonu, **12. YIL:** Yıldızelī, Sivas, **13. TUR:** Türkoğ lu, Kahramanmaraş, **14. KILS:** Kilis, 10 km east, **15. CEY:** Ceylanpınar, Şanliurfa, **16. DAR:** Darende, Malatya, **17. VAN:** Van, 10 km south, **18. ARA:** Aralık, Iğdır, **19. SUM:** Sümela, Trabzon, **20. KA:** Kars and Ardahan.

Results and Discussion

During this study, 41 rodent species were captured in 20 localities in Turkey (Fig.1). Of these, *Cricetulus migratorius, Rattus rattus*, and *Mus* aff. *musculus*, occurring in all localities studied, were identified as wide-ranging species. *Rattus norvegicus* were not trapped in localities studied that consist of rural areas, but this species is very common around urban areas (Yiğit et al. 1998a). *Apodemus hermonensis* and *Dryomys nitedula* were recorded in 16 and 15 different localities, respectively (Table 1). *A. hermonensis* was first reported in western Turkey by Filipucci et al. (1996). The following species, previously recorded from Turkey (Danford & Alston 1877; Thomas 1897; Thomas 1905; Neuhäuser 1936; Misonne 1957; Spitzenberger 1971 & 1978; Mursaloğlu 1973; Çolak & Kıvanç 1991; Doğramacı et al. 1994; Kıvanç et al. 1997a), were not taken in any of the localities studied: *Spermophilus citellus, Microtus arvalis, Microtus gud, Arvicola terrestris*, *Micromys minitus, Myomymus roachi, Eliomys quercinus, Dryomys pictus, Meriones persicus, Meriones libycus, Tatera indica, Nesokia indica, Acomys cilicicus, Calomyscus bailwardi* and *Myocastor coypus*. Another species, *Spalax nehringi*, was recently recorded from Turkey by Coşkun (1996); its occurrence and taxonomic status are under discussion. We did capture *S. citellus, A. terrestris, M. persicus*, *A. cilicicus* and *Rattus norvegicus* in other localities of Turkey, but not in localities described in this article (Kıvanç et al. 1997a; Yiğit & Çolak 1999; Özkurt et al. 1999; Yiğit et al. 1998a). In addition, we were told of the occurrence of *Castor fiber* in some virgin rivers in the coastal region of northern Anatolia by our colleagues and villagers.

Locality 11 had the highest rodent number with 17 species, followed by localities 9, 14 and 15 with 16 species each; locality 9 had the lowest rodent number with nine species (Table 1). Although we carried out thorough field studies in locality 14, we did not capture *Meriones sacramenti, M. libycus, M. vinogradovi, Nesokia indica and Tatera indica*, all recorded at locality 14 by Misonne (1957). Zahavi & Wahrman (1957) stated that *M. sacramenti* is endemic to Israel and was wrongly reported from this locality.

The similarity coefficient between the localities ranged from 1 to 0.512 (Table 2). Cluster analyses showed that the 20 localities studied formed three main clusters: the first is the northern localities (1, 9, 10, 19); the second is the western and central Anatolian localities (2, 3, 4, 5, 6, 7, 8, 11, 12, 16, 17, 18, 20); and the third is the south-eastern localities (13, 14, 15) (Fig. 2). The similarity coefficient ranged from 0.88 to 0.78 among localities of first main clusters, which are completely covered with mixed and deciduous forest. M and m values among these localities are also similar to each other (Tables 2, 3, 4). Seven rodent species (*Sciurus anomalus, C. migratorius, D. nitedula, Glis glis, Apodemus flavicollis, R. rattus*, *M.* aff. *musculus*) commonly occur in these four localities (Table 1). The main differences were the

Table 1. Rodent species trapped and their distribution according to the localities (+: occurrence status).

The Localities and their numbers	VEL 1	BAY 2	OVA 3	DEM 4	CAR 5	CIG 6	KIL 7	GOK 8	ABA 9	YEN 10	TOS 11	YIL 12	TUR 13	KILS 14	CEY 15	DAR 16	VAN 17	ARA 18	SUM 19	KA 20
Rodent Species																				
Spermophilus xanthoprymnus	–	–	–	–	+	–	+	+	–	–	+	+	–	–	–	+	+	+	–	+
Sciurus anomalus	+	+	+	+	–	+	–	+	+	+	+	–	–	–	–	+	–	–	+	+
Sciurus vulgaris	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Mesocricetus brandti	–	–	–	–	+	–	+	+	–	–	+	+	–	–	–	+	+	+	–	+
Mesocricetus auratus	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–
Cricetulus migratorius	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Meriones tristrami	–	+	–	+	+	–	+	+	–	–	+	–	+	+	+	+	–	+	–	–
Meriones vinogradovi	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
Meriones meridianus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
Meriones crassus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gerbillus dasyurus	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–
Clethrionomys glareolus	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	+	–
Microtus guentheri	–	+	–	+	+	+	+	+	+	–	+	–	+	+	+	–	–	–	–	–
Microtus subterraneus	+	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–
Microtus roberti	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Microtus nivalis	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Microtus irani	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–
Microtus socialis	–	–	–	–	–	–	–	–	–	–	–	+	–	+	+	+	+	–	–	+
Microtus epiroticus	+	–	–	–	+	–	+	+	+	–	+	+	–	–	–	+	+	+	+	+

Table 1. ctd.

Rodent Species																				
Microtus majori	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Prometheomys schaposchnikowi	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Ellobius lutescens	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
Spalax leucodon	–	+	+	+	+	+	+	+	+	–	+	+	–	–	–	+	+	+	–	+
Spalax ehrenbergi	–	–	–	–	–	–	–	–	–	–	–	–	+	+	+	–	–	–	–	–
Dryomys nitedula	+	+	+	+	+	+	+	+	+	+	+	+	–	–	–	+	+	–	+	–
Dryomys laniger	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Muscardinus avellanarius	–	–	–	–	–	–	–	–	+	+	+	–	–	–	–	–	–	–	+	–
Glis glis	+	–	–	–	–	–	–	–	+	+	+	–	–	–	–	–	–	–	+	–
Apodemus sylvaticus	+	+	+	+	+	–	–	–	+	–	+	–	+	+	+	+	+	+	+	+
Apodemus flavicollis	+	+	+	+	+	–	+	+	+	+	+	–	–	–	–	–	–	–	+	–
Apodemus agrarius	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Apodemus mystacinus	+	+	+	+	–	+	+	+	–	+	–	+	–	+	+	+	+	–	+	–
Apodemus hermonensis	–	–	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	–	+	–
Apodemus uralensis	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–	–	–
Rattus rattus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mus aff. *musculus*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sicista caucasica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Allactaga williamsi	–	–	–	+	+	–	+	+	–	–	+	+	–	–	–	+	+	+	–	+
Allactaga euphratica	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	–
Allactaga elater	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
Hystrix indica	–	+	+	+	–	+	+	–	–	–	–	–	+	+	+	–	–	–	–	–
Total numbers	**13**	**12**	**11**	**14**	**12**	**15**	**15**	**16**	**13**	**17**	**12**	**9**	**16**	**15**	**14**	**13**	**14**	**13**	**15**	**14**

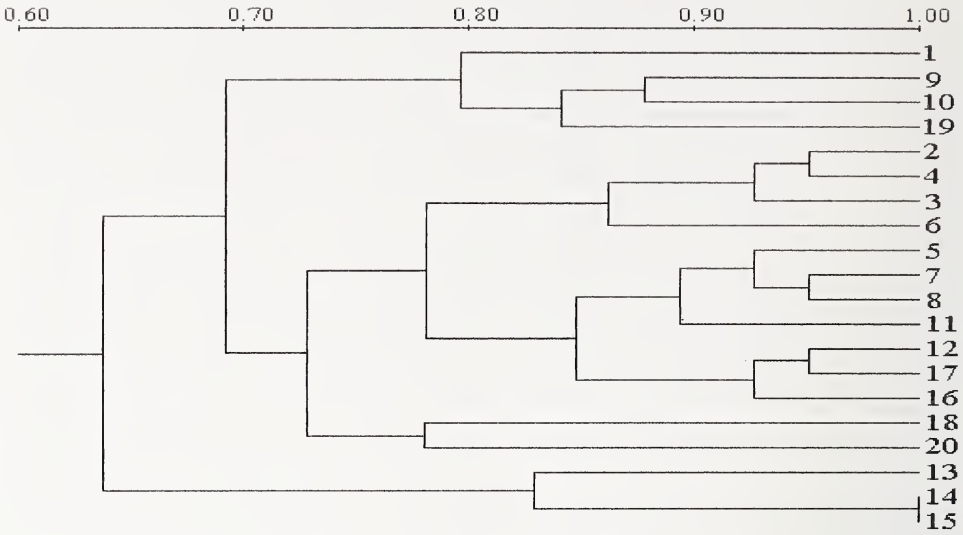

Fig. 2. UPGMA clustering of Simqual matrix for rodent composition of 20 localities studied.

occurrence of *Microtus subterraneus and Apodemus agrarius* in locality 1 and *Microtus roberti and M. majori* in locality 19. A detailed report was provided for *M. subterraneus* and *M. majori* by Çolak et al. (1998), contributing to the distribution of *M. majori* and *M. subterraneus* in northern Anatolia, and it noted that *M. majori* does not occur in Abant (locality 9). The first and second main clusters therefore joined at similarity 0.68.

The second main clusters consist of localities selected in western, central and eastern Turkey (Fig. 1). The similarity coefficient among these localities ranged from 0.95 to 0.73 (Table 2). This group is composed of four sub-clusters. The localities 2, 3, 4 and 6 constitute the first sub-cluster and are located in the coastal region of western and south-western Asiatic Turkey, respectively. When localities 2, 3, 4 were compared to locality 6, the four localities joined at similarity 0.85 to form sub-clusters (Table 2). The climatic and vegetation peculiarities of these localities are given in tables 3, 4. Although the climatic data and vegetation were very similar among these localities, *Dryomys laniger* and *Microtus nivalis* were only recorded in locality 6, the former being an endemic rodent species for Asiatic Turkey. The factors restricting its distribution in other forest areas are still unknown. *M. nivalis, M. guentheri* and *D. nitedula* were previously reported in locality 6 by Spitzenberger (1978) and Kıvanç et al (1997b). Steppe species such as *Cricetulus migratorius, Meriones tristrami* and *Allactaga williamsi* were caught in some parts of locality 4 where the forest had been cleared. Locality 2 is also at the western edge of the distribution of *M. tristrami* (Thomas 1905 & 1919). According to our finding, *Clethrionomys glareolus, Microtus subterraneus, M. majori, Glis glis and Muscardinus avellanarius*, which are distributed in the northern localities, do not occur in the localities 2, 3, 4 and 6 which have very dry summer months (Table 3). We suspect

that differences in climatic data, especially in precipitation, cause them to be absent from these localities.

The second sub-clusters consist of localities 5, 7, 8 in central and 11 in northern Anatolia (Fig. 1). The similarity coefficients vary between 0.95 and 0.89 in these localities (Table 2). Localities 5, 7 and 8 are characterized by steppe, and so the flora is composed mainly of steppe plants presented in table 4. However, some parts of locality 8 are covered with oak forest and bushes. Although northern Anatolia is generally covered with mixed forest, grain and rice fields are very abundant in locality 11. Because of this, steppe species such as *M. tristrami, A. williamsi* and *Mesocricetus brandti* manage to penetrate into this locality. Thus, locality 11 was determined to be near their range boundary in north-west Asiatic Turkey (Çolak et al. 1994; Yiğit at al. 1998b). In addition, we caught *S. anomalus* in locality 8 which has some forest areas. The climatic data of localities 5, 7 and 8 were very similar, but the m value of locality 5 was considerably higher than in localities 7 and 8. The main climatic difference between localities 5, 7, 8 and 11 is precipitation (Table 3). When these localities were compared with localities 12, 17, 16, which constitute the third sub-clusters and are also characterized by steppe (Fig. 1), the similarity coefficient between localities 5, 7, 8 and 11 and locality 12, 16 and 17 joined at similarity 0.85 (Table 2). The main differences among these localities are the occurrence of *Ellobius lutescens* in locality 17, and the absence of *M. tristrami* in localities 12, 17. *E. lutescens* was previously recorded from locality 17 by Coşkun (1997). The high mountains that extend diagonally from south Anatolia to north-east Anatolia should be considered as the main factors preventing *E. lutescens* from penetrating into central Anatolia. Although extensive field studies have been carried out in localities 12 and 17, we did not catch *M. tristrami* in these localities. The factor restricting *M. tristrami*'s distribution in these localities is still unclear.

Table 2. Simqual similarity matrix for qualitive data of 20 localities studied (see Table 3).

1.000																		
0.780	1.000																	
0.804	0.926	1.000																
0.731	0.951	0.926	1.000															
0.682	0.804	0.780	0.853	1.000														
0.682	0.853	0.878	0.853	0.707	1.000													
0.658	0.829	0.804	0.878	0.926	0.780	1.000												
0.707	0.829	0.804	0.878	0.926	0.780	0.951	1.000											
0.780	0.756	0.780	0.756	0.756	0.707	0.682	0.731	1.000										
0.804	0.731	0.804	0.731	0.634	0.731	0.658	0.707	0.878	1.000									
0.707	0.780	0.756	0.829	0.926	0.682	0.853	0.902	0.829	0.707	1.000								
0.682	0.707	0.780	0.756	0.853	0.756	0.878	0.878	0.658	0.682	0.780	1.000							
0.658	0.829	0.804	0.829	0.780	0.780	0.756	0.707	0.682	0.658	0.707	0.682	1.000						
0.536	0.707	0.682	0.707	0.609	0.658	0.634	0.585	0.512	0.536	0.536	0.609	0.829	1.000					
0.536	0.707	0.682	0.707	0.609	0.658	0.634	0.585	0.512	0.536	0.536	0.609	0.829	1.000	1.000				
0.707	0.780	0.804	0.829	0.878	0.731	0.853	0.902	0.682	0.658	0.853	0.926	0.707	0.634	0.634	1.000			
0.682	0.707	0.780	0.756	0.853	0.707	0.829	0.829	0.658	0.634	0.780	0.951	0.682	0.609	0.609	0.926	1.000		
0.609	0.682	0.658	0.682	0.829	0.585	0.756	0.756	0.585	0.512	0.756	0.780	0.707	0.536	0.536	0.804	0.780	1.000	
0.804	0.731	0.804	0.731	0.682	0.682	0.658	0.707	0.829	0.853	0.756	0.682	0.658	0.536	0.536	0.707	0.682	0.560	1.000
0.682	0.658	0.682	0.658	0.756	0.609	0.682	0.731	0.609	0.536	0.731	0.804	0.634	0.512	0.512	0.829	0.804	0.780	0.585	1.000

Table 3. Average monthly precipitation by season and M and m values of the localities.

The localities and their numbers	Precipitation mm^3/m^2 Winter	Spring	Summer	Autumn	Total	Climatic data M. m values
1. Velika / Kırklareli	102, 4	59,4	31,9	78,4	815,4	Rainy, temperate type Mediterranean climate. M: 34,4, m: 4.4
2. Bayındır / İzmir	125	50	6.3	47	684	Less rainy, temperate type Mediterranean climate. M: 34.4, m: 4.4
3. Ovacık / İzmir	129	43	1.5	45	655	Less rainy, cold type Mediterranean climate. M: 28, m: -2.2
4. Demirci / Manisa	109	64	13	49	705	Less rainy, cold type Mediterranean climate. M: 25, m: -3.1
5. Çardak / Denizli	51	44	15	24	402	Semiarid, cold type Mediterranean climate. M: 31,9, m: 0.2
6. Çiğlıkara / Antalya	96	38	13	29	528	Semiarid, cold type Mediterranean climate. M: 31,9, m: 0.2 ***
7. Kılbasan / Karaman	36	34	10	20	300	Semiarid, veryd cold type Mediterranean climate. M: 30.3, m: -3.1
8. Gökçekısık / Eskişehir	43	41	19	24	381	Semiarid, very cold type Mediterranean climate. M: 28.4, m: -3.5
9. Abant / Bolu	57	53	34	38	546	Semiarid, very cold type Mediterranean climate. M: 25.7, m: -3.1
10. Yenikonak / Bursa	160	110	37	89	1184	Rainy,cold type Mediterranean climate. M: 25, m: -1.8
11. Tosya / Kastamonu	50	51	28	27	468	Semi continental, semiarid, cold type climate. M: 27,1, m: -2.5
12. Yıldızeli / Sivas	42	55	13	22	399	Semiarid, very cold type Mediterranean climate. M: 27,8, m: -7.7
13. Türkoğlu / Kahramanmaraş	157	77	3	34	813	Less rainy, cold type Mediterranean climate. M: 35.0, m: 0.9
14. Kilis 10 km east	93	50	3	30	528	Semiarid, cold type Mediterranean climate. M: 35,0, m: -1,6
15. Ceylanpınar / Şanhurfa	54	39	0.7	16	330	Semiarid, cold type Mediterranean climate. M: 40.6, m: 0.5
16. Darende / Malatya	42	52	11	43	383	Semiarid, very cold type Mediterranean climate. M: 29.9, m: -5.1
17. Van 10 km south	34	49	9	35	381	Semiarid,very cold type Mediterranean climate. M: 28.2, m:-8.0
18. Aralık / Iğdır	15	28	10	13	198	Arid, cold type Mediterranean climate. M: 32.7, m: -8.4
19. Sümela / Trabzon	57.9	77.7	46.0	57.7	718.8	Less rainy, cold type Mediterranean climate. M: 25, m: -3.1
20. Kars and Ardahan	19.4	48.9	70.1	31	508.6	Less rainy, cold type Mediterranean climate. M: 25, m: -3.1

The fourth sub-cluster consists of localities 18, 20, and the similarity coefficient is 0.78 between localities 18 and 20, which are close to each other (Fig. 1; Table 2). This value is comparatively low, the main reason for the difference arose from locality 18. Locality 18 is interesting and its habitat is classified principally in two categories (Table 4): sandy plains toward the hillside, and marshy plains, sometimes completely flooded in the winter months. The vegetation structure of these habitat types is very different (Table 4). *Meriones meridianus, M. vinogradovi* and *Allactaga elater* are only present there. Indeed *M. meridianus and M. vinogradovi* were first recorded from Aralık by Yiğit et al. (1998c), and a subspecies of *A. elater* (*A. e. aralychensis*) was first described from Aralık by Satunin (1908). Another species of the genus *Allactaga* (*A. williamsi*) also occurs in this locality, ranging from the east to the west, except in localities 14 and 15 in southeastern Turkey. *M. meridianus* was caught only in sandy areas, and was found not to be penetrating into wet plains in locality 18. In contrast, *M. tristrami, M. vinogradovi* and *A. elater* were not caught in the sands, although *A. elater* is known to inhabit sandy areas (Shenbrot et al. 1994; Vinogradov & Argyropulo 1941). In addition, Vinogradov & Argyropulo (1941) and Heptner (1975) have described *M. meridianus* as inhabiting sandy areas, which is consistent with our findings. Detailed taxonomic studies were also performed on *M. meridianus*, *M. vinogradovi*, *A. elater* and *A. williamsi* by Yiğīt et al. (1997b & 1998c); Çolak et al. (1994 & 1997a). In localities 18 and 20, *Mesocricetus brandti*, *Sicista caucasica, Sciurus anomalus, S. vulgaris, Microtus socialis* and *Prometheomys schaposchnikowi* are distributed only in locality 20, and not in locality 18. *P. schaposchnikovi* was recorded from two different localities in north-east Turkey by Çolak et al. (1999). In addition to this, Demirsoy (1996) noted, in his brief revision, that *S. caucasica* is distrubed in north-east Turkey, and his report is consistent with our findings. These differences in species composition were probably due to elevation and climate (Table 3, 4). Annual precipitation and elevation in these localities are very different from each other; locality 20 is covered with snow for long periods during the winter unlike locality 18. Second and third main clusters join at similarity 0.64.

The third main cluster is composed of the localities 13, 14, and 15 in south-eastern Turkey (Fig. 1). Localities 14 and 15 have a similarity coefficient of 1 with each other and of 0.83 with locality 13 (Table 2, Fig. 2). Locality 13 had the lowest rodent number with nine species (Table 2). Although localities 13, 14 and 15 form a cluster, and there is geographic proximity among these localities, the rodent composition and climatic data are very different between locality 13 and localities 14, 15 (Table 1, 3, 4). Localities 14 and 15 are surrounded by highland areas in the north with an elevation of over 1000 m. The average annual precipitation of locality 13 is very different from that of localities 14 and 15, which have a dry summer period (Table 3). Thus, species accustomed to semi-arid conditions were found in localities 14 and 15. *Meriones crassus, Gerbillus dasyurus, Microtus irani, Spalax ehrenbergi* and *Allactaga euphratica* were only recorded from these localities. Whereas species that range over the central Anatolia steppes, such as *A. williamsi, M. brandti, Spermophilus xanthoprymnus, Spalax leucodon* and *Microtus epiroticus* were not caught in localities 13, 14 and 15. *M. crassus* and *G. dasyurus* were first recorded from localities 14 and 15 by Yiğīt et al. (1998c & 1997a). Additionally, the taxonomic status of *A. euphratica* and *M. irani* was revealed by Çolak et al. (1994 & 1997b). Our findings agree with the habitats specified by Haim & Tchernov (1974); Brown (1980)

Table 4. Some geographical and ecological remarks on localities in which the studies were performed. La.: Latitude, Lon.: longitude, El.: Elevation (m).

The localities	La.	Lon.	El.	The peculiarity of the localities and dominant plant species
1. Velika / Kırklareli	41.49	27.46	800	This locality consists of mixed forest with *Philyrea latifoloa, Fagus orientalis, Quercus pubescens, Quercus cerris.*
2. Bayındır / İsmir	38.13	37.39	100	This locality partly consists of cultivated areas, open hill sides, olive trees and shrubs (*Pinus brutia, Cistus creticus, Rhus coriaria, Olea europaea* var. *oleaster, Pistacia lentiscus, Quercus coccifera*)
3. Ovacık / İzmir	38.8	27.45	1150	This locality was dominantly covered with pines (*Pinus brutia, Cistus creticus, Rhus coriaria, Pistacia terebinthus*)
4. Demirci / Manisa	39.03	28.39	1350	This locality has the forested areas with pine, fruits and open fields in forest (*Pinus nigra* ssp. *pallasiana, Quercus cerris, Q. pubescens*)
5. Çardak / Denizli	37.50	29.40	920	This locality studied consists of grain fields and steppe (*Astragalus* sp., *Medicago radiata, Festuca* sp., *Cynodon* sp., *Thymus* sp., *Polyogonum* sp.)
6. Çığlıkara / Antalya	36.43	29.55	1250	This locality was partly covered with mixed forests (*Pinus nigra* ssp. *pallasiana, Cedrus libani, Juniperus excelsa, Juniperus oxycedrus*)
7. Kılbasan / Karaman	37.19	33.11	1050	This locality consists of grain fields and steppe (plant species is the same as in Cardak / Denizli)
8. Gökçekısık / Eskişehir	39.39	30.20	900	This locality consists of grain fields and steppe (*Salvia cryptantha, Thymus spyleus, Ziziphora capitata, Teucrium polium*)
9. Abant / Bolu	40.40	31.45	1100	This locality is utterly covered with mixed forest (*Abies nordmanniana, Fagus orientalis, Corpinus betulus, Populus tremula, Quercus infectoria, Q. cerris*)
10. Yenikonak / Bursa	40.07	29.10	1025	This locality is utterly covered with mixed forest (vegetation structure is the same as in Abant / Bolu)
11. Tosya / Kastamonu	41.01	34.02	870	This locality consists of mixed forest, shrubs and grain fields (*Quercus pubescens, Cistus laurifolius, Crataequs monogyna, Cotonaastere nummalaria*).
12. Yıldızeli / Sivas	39.52	36.36	1415	This locality is high steppe with *Astragalus angustifolius, Salvia aethiopis, Senecio vernalis, Hyoscyamus niger.*
13. Türkoğlu / Kahramanmaraş	37.24	36.61	520	This locality is composed of wetland, corn fields and swamp (*Cyperus longus, Carex otrubae, Bolbochoenus maritimus, Scilla bifolia*).
14. Kilis 10 km east	36.43	37.07	650	This locality has grain fields, natural steppe and rocky hills. Plant species is the same as in Ceylanpinar / Sanhurfa.
15. Ceylanpınar / Şanhurfa	36.51	40.03	400	This locality consists of cultivated areas and natural steppes (*Hordeum* sp. *Eryngium* sp., *Securigera* sp., *Peganum* sp., *Agropyron* sp.).
16. Darende / Malatya	38.33	37.31	1200	This locality has steppe and grain fields in roughness areas (*Centranthus longiflorus, Parietaria judaica, Torilis leptophyla, Eryngium campeste*).
17. Van 10 km south	38.27	43.19	1700	This locality includes high steppe and grain fields (*Festuca valesiaca, Eremopoa songarica, Bromus danthoniae, Ornithogalum* sp.).
18. Aralik / Iğdır	39.53	44.31	825	This place is briefly composed of two types of localities. First is sandy, consists of following plant species: *Equisetum ramosimum, Atraphaxis billardieri, Crucifera* sp., *Crepis* sp., *Medicago* sp., *Euphorbia* sp., Latter is watery, plains consist of following plant species: *Juncus* sp., *Dactylis* sp., *Alysum* sp., *Erysimum* sp., *Carex* sp.
19. Sümela / Trabzon	40.47	39.37	1100	This locality is utterly covered with mixed forest (*Castanea sativa, Alnus glutinosa, Picea orientalis, Fagus orientalis, Juglans regia, Carpinus orientalis*).
20. Kars and Ardahan	41.07	42.43	1829	This locality is high steppe, and is dominantly covered with *Bromus tomentellus, Festuca valesiaca, Astragalus microcephalus, Agroppyron repens, Echinops ritrio, Eryngium campestre.*

and Shenbroth et al. (1994). We conclude that the cold climate and elevation affect the distribution of the species recorded from localities 14 and 15 into central Anatolia.

The similarity in the species compositions was found to vary greatly in localities with similar habitats such as forests, steppes, sands and wetlands. The temperature, elevation, precipitation and humidity were also found to vary from locality to locality, all of which are factors contributing to species composition in Turkey. The climatic diversity, geographic barriers that extend from south-eastern into northern Anatolia, and the connection of Anatolia with three continents, Europe, Asia and Africa, all resulted in faunistic and floristic diversity. Arboreal rodent species from the European continent, steppe species from Caucasia and arid-semi arid land species from Africa occupy different habitats in Anatolia. Niethammer & Krapp (1978 & 1982) stated that 61 rodent species live in the European continent. Considering Niethammer & Krapp (1978 & 1982), it can be said that Turkey is very rich in rodent species compared to the European continent.

Acknowledgements

This study was funded in part by the Research Fund of the Ankara University (No: 91250055, 91250072, 95050301, 96050306, 97050304, 98050308) and The Scientific and Technical Research Council of Turkey (TÜBÝTAK) (TBAG: 1186 and 1187). We thank Dr. Latif Kurt for identifying plant species and for his many helpful comments.

Zusammenfassung

An 20 ausgesuchten Orten der Türkei wurden Nagerarten gesammelt. Diese Orte wurden dann auf Artenzusammensetzung untersucht und miteinander verglichen. Insgesamt wurden 41 Nagerarten gefunden, 9 bis 17 an jedem Ort. Arten, die früher in Misch- und Laubwald in der nordasiatischen Türkei festgestellt worden waren, wie *Glis glis, Muscardinus avellanarius, Microtus subterraneus, Microtus roberti, Microtus majori, Sciurus vulgaris* und *Clethrionomys glareolus*, wurden in bewaldeten Gegenden der west- und südasiatischen Türkei mit trockenem Sommer nicht gefunden. *Apodemus agrarius* wurde nur im türkischen Thrakien verzeichnet. Ähnliche Habitate an verschiedenen Orten hatten Nageransammlungen mit beträchtlichen Unterschieden in der Artenzusammensetzung. Vegetation, Klima und Höhe wurden als Hauptfaktoren für die Verbreitung von Nagerarten in der Türkei ermittelt.

References

Aharoni, B. (1932): Die Muriden von Palastina und Syrien. – Z. Säugetierk. 11: 161–240.

Atallah, S. I. (1977): Mammals of the eastern Mediterranean region: their ecology, systematics and zoogeographical relationships. – Säugetierk. Mitt. 26: 1–50.

Barrett-Hamilton, G. E. H. (1900): On geographical and individual variation in *Mus sylvaticus* and its allies. – Proc. Zool. Soc. Lond. 1900: 378–428, pl. 25.

Blackler, W. F. G. (1916): On a new species of *Microtus* from Asia Minor. – Ann. Mag. nat. Hist. 17: 426–427.

Bodenheimer, F. S. (1958): The present taxonomic status of the terrestrial mammals of Palestine. – Bull. Res. Counc. of Israel 7b: 165–190.

Brown, R. E. (1980): Rodents of the Kavir National Park, Iran. – Mammalia 44: 89–96.

Corbet, G. B. (1978): The mammals of the Palaearctic region: a taxonomic review. – Brit. Mus. Nat. Hist. & Cornell Univ. Press, London.

Coşkun, Y. (1996): A new subspecies of *Spalax nehringi* (Satunin, 1898) (Rodentia: Spalacidae) from Turkey. – Säugetierk. Mitt. 37: 103–109.

Coşkun, Y. (1997): Türkiye *Ellobius lutescens* Thomas, 1897 (Rodentia: Cricetidae) Türünün Morfolojik ve Karyolojik Özellikleri. – Tr. J. Zoology 21: 349–354.

Çolak, E. & E. Kıvanç (1991): Distribution and taxonomic status of genus *Clethrionomys* Tilesius, 1850 (Mammalia: Rodentia) in north Anatolia. – Commun. Fac. Sci. Univ. Series C, V. 9: 1–16.

Çolak, E., E. Kıvanç & N. Yiğit (1994): A study on taxonomic status of *Allactaga euphratica* Thomas, 1881 and *Allactaga williamsi* Thomas, 1897 (Rodentia: Dipodidae) in Turkey. – Mammalia 58: 591–600.

Çolak, E., E. Kıvanç & N. Yiğit (1997a): *Allactaga elater aralychensis* (Satunin, 1901) in Taksonomik Durumu ve Yayilisi. – Tr. J. Zoology 21: 355–360.

Çolak, E., N. Yiğit, M. Sözen & Þ. Özkurt (1997b): Distribution and taxonomic status of the genus *Microtus* (Mammalia: Rodentia) in south-eastern Turkey. – Israel J. Zoology, 43: 391–396.

Çolak, E., N. Yiğit, M. Sözen & Þ. Özkurt (1998): A study on taxonomic status of *Microtus subterraneus* (de Selys Longchamps, 1836) and *Microtus majori* Thomas, 1906 (Mammalia: Rodentia), in Turkey. – Tr. J. Zoology 22: 119–129.

Çolak, E., N. Yiğit & R. Verimli (1999): On the karyotype of the long-clawed mole rat, *Prometheomys schapochnikovi* Satunin, 1901 (Mammalia: Rodentia) in Turkey. – Z. Säugetierk. 64: 1–2.

Danford, C. G. & E. R. Alston (1877): On the mammals of Asia Minor. – Proc. Zool. Soc. London 270–282.

Demirsoy, A. (1996): Türkiye Omurgalıları "Memeliler". – Çevre Bakanlığı Çevre Koruma Genel Müdürlügü Proje no: 90 – K – 1000 – 90, Ankara.

Doğramacı, S. (1989): Türkiye Memeli Faunası için Yeni Bir Tür, *Microtus epiroticus* (Mammalia: Rodentia). – Tr. J. Zoology 13: 197–203.

Doğramacı, S., H. Kefelioğlu & I. Gündüz (1994): Türkiye *Spermophilus* (Mammalia: Rodentia) Cinsinin Karyolojik Analizi. – Tr. J. Zoology 18 (3): 167–170.

Ellerman, J. R. (1948): Key to the Rodents of south-west Asia in the British museum collection. – Proc. Zool. Soc. 118: 765–816.

Felten, H. & G. Storch (1968): Eine neue Schläferart *Dryomys laniger* n. sp. aus Kleinasien (Rodentia: Gliridae). – Senckenberg. Biol. 49: 429–435.

Felten, H., F. Spitzenberger & G. Storch (1971): Zur Kleinsäugerfauna West-Anatoliens, Teil 1. – Senckenberg. Biol. 52: 393–424.

Felten, H., F. Spitzenberger & G. Storch (1973): Zur Kleinsäugerfauna West-Anatoliens, Teil 2. – Senckenberg. Biol. 54: 227–290.

Filipucci, M. G., G. Storch & M. Macholan (1996): Taxonomy of the genus *Sylvaemus* in Western Anatolia – Morphological and electrophoretic evidence. – Senckenberg. Biol. 75: 1–14.

Haim, A. & E. Tchernov (1974): The distribution of myomorph rodents in the Sinai Peninsula. – Mammalia 38: 201–223.

Harrison, D. L. & P. J. J. Bates (1991): The Mammals of Arabia. – Second Edition. Harr. Zool. Museum Pub. Kent, England.

Hatt, R. T. (1959): The mammals of Iraq. – Miscellaneous Publs Mus. Zool. Univ. Mich. 106: 1–113.

Heptner, W. G. (1975): Über einige Besonderheiten der Formbildung und der geographischen Verbreitung der Rennmaus, *Meriones* (*Pallasiomys*) *meridianus* Pallas, 1773. – Z. Säugetierk. 40: 261–269.

Kahmann, H. (1961): Beiträge zur Säugetierkunde der Türkei. 2. Die Brandmaus (*Apodemus agrarius* Pallas, 1774) in *Thrakien* und die südeuropäische Verbreitung der Art. – Rev. Fac. Sci. Univ. Istanbul 26: 87–106.

Kefelīoğlu, H. (1995): Türkiye *Microtus* (Mammalia: Rodentia) Cinsinin Taksonomisi ve Yayılısı. - Tr. J. Zoology 19: 35–63.

Kıvanç, E. (1983): Die Haselmäuse, *Muscardinus avellanarius* L., in der Türkei. – Bonn. zool. Beitr. 34: 419–428.

Kıvanç, E. (1986): *Microtus* (*Pitymys*) *majori* Thomas, 1906 in der europäischen Türkei. – Bonn. zool. Beitr. 37: 39–42.

Kıvanç, E., M. Sözen, E. Çolak & N. Yiğit (1997a): Karyologic and phallic aspects of spiny mouse, *Acomys cilicicus* Spitzenberger, 1978 (Rodentia: Muridae) in Turkey. – Tr. J. Zoology 21: 167–169.

Kıvanç, E., M. Sözen, E. Çolak & Yiğit, N. (1997b): Karyologic and phallic characteristics of *Dryomys laniger* Felten and Storch, 1968 (Rodentia: Gliridae) in Turkey. – Israel J. Zool. 43: 401–403.

Kurtonur, C. & B. Özkan (1991): New records of *Myomimus roachi* (Bate, 1937) from Turkish Tharace (Mammalia: Rodentia: Gliridae). – Senckenberg. biol. 71: 239–244.

Lay, D. M. (1967): A study of the mammals of Iran, resulting from the street Expedition of 1962–63. – Fieldiana Zool. 54: 1–282.

Lehmann, E. von (1966): Taxonomische Bemerkungen zur Säugerausbeute der Kumerloeveschen Orientreisen. – Zool. Beitr. 12: 251–317.

Lehmann, E. von (1969): Eine neue Säugetieraufsammlung aus der Türkei im Museum Koenig (Kumerloeve-Reise 1968). – Zool. Beitr. 15: 299–327.

Miller, G. S. (1908): New mammals from Asia Minor. – Ann. Mag. nat. Hist. 1: 102–103.

Misonne, X. (1957): Mammifères de la Turquie Sub-orientale et du nord de la Syrie. – Mammalia 21: 53–57.

Misonne, X. (1959): Analyse zoogéographique des mammifères de l'Iran. – Mem. Inst. Sci. Natur. Belg. Bruxelles 2:1–157.

Morlok, W. F. (1978): Nagetiere aus der Türkei (Mammalia: Rodentia). – Senckenberg. Biol. (3–4) 59: 155–162.

Mursaloğlu, B. (1965): Geographic variation in *Citellus citellus* (Mammalia: Rodentia) in Turkey. – Türk Biol. Derg. 10: 78–109.

Mursaloğlu, B. (1973): New records for Turkish rodents (Mammalia). – Communications (C) 17: 214–219.

Nehring, A. (1903): Über eine Springmaus aus Nordwest-Kleinasien (*Allactaga williamsi laticeps*, n. subsp.). – Sitz. Ges. naturf. Freunde 4: 357–360.

Neuhäuser, G. (1936): Die Muriden von Kleinasien. – Z. Säugetierk. 2: 161–236.

Niethammer, J. & F. Krapp (1978): Handbuch der Säugetiere Europas. – Akademische Verlagsgesellschaft, Band I Rodentia I. Wiesbaden, Germany.

Niethammer, J. & F. Krapp (1982): Handbuch der Säugetiere Europas. – Akademische Verlagsgesellschaft, Band 2/1 Rodentia II. Wiesbaden, Germany.

Ondrias, J. C. (1966): The taxonomy and geographical distribution of the rodents of Greece. – Säugetierk. Mitt. 14: 1–136.

Osborn, D. J. (1962): Rodents of subfamily Microtinae from Turkey. – J. Mammalogy 43: 515–529.

Osborn, D. J. (1965): Rodents of subfamilies Murinae, Gerbillinae, and Cricetinae from Turkey. – The journal of the Egyptian Public Health Association XL: 401–421.

Özkurt, Þ., E. Çolak, N. Yiğit, M. Sözen & R. Verimli (1999): Contribution to karyology and morphology of *Arvicola terrestris* (Lin., 1758) in Central Anatolia. – Tr. J. Zoology 23: 253–257.

Rolf, J. F. (1988): NTSYS-pc Numerical Taxonomy and Multivariate Analysis System, Version 1.50. – Exeter Publishing LTD, New York.

Satunin, K. A. (1908): Beiträge zur Kenntnis der Säugetierfauna Kleinasiens u. Transkaspiens. – Mitt. Kaukas. Mus. Tiflis 4: 42–141.

Shenbrot, G. I., K. A. Rogovin & E. J. J. Heske (1994): Comparison of Niche-packing and Community Organisation in Desert Rodent in Asia and North America. – Aust. J. Zool. 42: 479–499.

Spitzenberger, F. & H. Steiner (1964): *Prometheomys schaposchnikovi* in Nordost-Kleinasien. – Z. Säugetierk. 79: 116–124.

Spitzenberger, F. (1971): Zur Systematik und Tiergeographie von *Microtus* (*Chinomys*) *nivalis* und *Microtus* (*Chinomys*) *gud* (Microtinae: Mammalia) in S. Anatolien. – Z. Säugetierk. 36: 370–380.

Spitzenberger, F. (1978): Die Stachelmaus von Kleinasien, *Acomys cilicicus* n. sp. – Annaln naturhist. Mus. Wien 81: 443–446.

Steiner, H. & G. Vauk (1966): Säugetiere aus dem Beysehir Gebiet (Vilayet Konya, Kleinasien). – Zool. Anz. 176: 97–102.
Thomas, O. (1897): On two new rodents from Van, Kurdistan. – Ann. Mag. nat. Hist. (6) 20: 308–310.
Thomas, O. (1903): On two new Muridae from Smyrna. – Ann. Mag. nat. Hist. (12) 7: 188–190.
Thomas, O. (1905): On a collection of mammals from Persia and Armenia presented to the British Museum by Col. A. C. Bailward. – Proc. Zool. Soc. London 2: 519–527.
Thomas, O. (1906): New Insectivores and Voles collected by Mr. A. Robert near Trabezond. – Ann. Mag. nat. Hist. 17: 418–419.
Thomas, O. (1919): Notes on gerbils referred to the genus *Meriones*, with descriptions of new species and subspecies. – Ann. Mag. nat. Hist. 9: 263–273.
Vinogradov, B. S. & A. I. Argyropulo (1941): Fauna of the USSR. Mammals. Key to the rodents (Translated from Russian). – Leningrad Pub., Moscow.
Yiğit, N., E. Çolak, E. Kıvanç, & M. Sözen (1997a): A new gerbil from Turkey *Gerbillus dasyurus* Wagner, 1836 (Rodentia: Gerbillinae). – Israel J. Zool. 43: 13–18.
Yiğit, N., E. Kıvanç & E. Çolak (1997b): Türkiye'deki *Meriones* Illiger, 1811 (Mammalia: Rodentia) Türlerinin Teshis Karakterleri ve Yayılısı. – Tr. J. Zoology 21: 361–374.
Yiğit, N. E. Çolak, M. Sözen & S. Özkurt (1998a): The taxonomy and karyology of *Rattus norvegicus* (Berkenhout, 1769) and *Rattus rattus* (Linnaeus, 1758), in Turkey. – Tr. J. Zoology 22: 203–212.
Yiğit, N., E. Kıvanç & E. Çolak (1998b): On the taxonomic status of *Meriones tristrami* Thomas, 1892 (Rodentia: Gerbillinae) in Turkey. – Zoology in the Middle East 16: 19–30.
Yiğit, N., E. Kıvanç & E. Çolak (1998c): Contribution to taxonomy and karyology of *Meriones meridianus* (Pallas, 1773) and *Meriones crassus* Sundevall, 1842 (Rodentia: Gerbillinae) from Turkey. – Z. Säugetierk. 63: 311–314.
Yiğit, N. & E. Çolak (1999): A study of the taxonomy and karyology of *Meriones persicus* (Blanford, 1875) (Mammalia: Rodentia) in Turkey. – Tr. J. Zoology 23: 269–274.
Zahavi, A. & J. Wahrman (1957): The cytotaxonomy, ecology and evolution of the gerbils and jirds of Israel (Rodentia: Gerbillinae). – Mammalia 2: 341–380.

Dr. Nuri Yiğit, Dr. Ercüment Çolak & Dr. Mustafa Sözen, University of Ankara, Faculty of Science, Department of Biology, 06100 Besevler, Ankara, Turkey; Dr. Sakir Özkurt, Gazi University, Education Faculty of Kırsehir, Department of Biology, Kırsehir, Turkey.